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REMARKS UPON A PAPER "ON THE BUILDING MATERIALS OF THE UNITED STATES OF NORTH AMERICA.—*By* DAVID STEVENSON, *C. E., Edinburgh.*"—*Read before the Society of Arts for Scotland, in session,* 1841.

In noticing the omissions of Mr. Stevenson in the last number of this journal, no reference was made to our hydraulic and other limes. As these are most essentially building materials, a few remarks upon them may not be improper before proceeding to notice that portion of the paper which relates to timber.

The great variety and extent of the limestone throughout the country, is too well known to need extended notice. While one portion furnishes good stone for building, including marble, and another an inferior lime highly useful as a manure—a very large quantity of good lime for mortar, is to be procured over the whole county.

It is true the Thomaston lime from its high reputation and the low cost at which it is furnished, has prevented many other excellent limestones from coming into extensive uses, but still lime *is* manufactured in very many places, and the business is continually on the increase. Hydraulic limestone is also abundant and instances of its occurrence are familiar to all who have been employed on such works as involve the employment of this material. Indeed it is not unlikely, that hydraulic limes are more abundant than pure limestones, and in course of time, they may, for many purposes, replace common lime.

The bituminous limestone, resembling that of Seysal, is known to be frequently found, and should the preparation known as "asphalte" ever come into general use, we have an abundance of the material at hand without the necessity of importing it.

In the same connection, we might also mention our fire clays which are numerous and excellent, and as an important material for the founder, the builder, and the manufacturer, are not to be overlooked in a survey of our resources.

The notice of our timber is prefaced by the following general remarks:—

"The forests, to the British eye, are perhaps the most interesting features in the United States, and to them, the Americans are indebted for the greater part of the materials of which their public works are constructed. These forests are understood to have originally extended, with little exception, from the sea coast to the confines of the extensive prairies of the western States; but the effects of cultivation can now be traced as far as the foot of the Alleghany mountains, the greater part of the land between them and the ocean having been cleared and brought into cultivation. It is much to be regretted that the early settlers, in clearing this country, were not directed by a systematic plan of operations, so as to have left some relics of the natural produce of the soil, which would have sheltered the fields and enlivened the face of the country, while at the same time they might, by cultivation, have been made to serve the more important object of promoting the growth of timber. Large tracts of country, however, which were formerly thickly covered with the finest timber, are now almost without a single shrub, every thing having fallen before the woodman's axe; and in this indiscriminate massacre there can be no doubt that many millions of noble trees have been left to rot, or what is scarcely to be less regretted, have been consumed as fire-wood. This work of general destruction is still going forward in the western States, in which cultivation is gradually extending; and the formation of some laws regulating the clearing of land, and enforcing an obligation on every settler to save a quantity of timber, which might perhaps, be made to bear a certain proportion to every acre of land which is cleared, is a subject which I should conceive to be not unworthy of the attention of the American Government, and one which is intimately connected with the future prosperity of the country. But should population and cultivation continue to increase in the same ratio, and the clearing of land be conducted in the same indiscrimnate manner as hitherto, another hundred years may see

the United States a *treeless* country. The same remarks apply, in some measure, to our own provinces of Upper and Lower Canada, in many parts of which the clearing of the land has shorn the country of its foliage, and nothing now remains but blackened and weather-beaten trunks.

"The progress of population and agriculture, however, has not as yet been able entirely to change the natural appearance of the country. Many large forests and much valuable timber still remain both in Canada, and in the United States; the Alleghany mountains, as well as other large tracts of country towards the north and west, which are yet uninhabited, being still covered with dense and unexplored forests."

Mr. S. does not seem to have distinguished sufficiently between the clearing of a thickly wooded country and the indiscriminate and wanton destruction of our forest trees. While there is some reason for the complaint which he makes, yet the "destruction" is greatly overrated. Tolerably familiar with some of the oldest settled parts of the country, we have not yet seen these large tracts formerly well wooded which "are now almost without a single shrub." For instance, from within a mile or so of the city of New York, the forest may be traversed in one case twenty-five and in another, thirty or forty miles with scarcely a single interruption, except from the woods crossing the path. We have heard the bells of the city in a forest which has never been cleared, and where hundreds of trees are now standing which probably were in existence when Columbus discovered the New World. We are however, informed by Mr. S. that "many large forests and much valuable timber still remain"—a consolation that we must thankfully receive.

The remarks upon timber generally, appear to be taken from works known to most of our readers and we shall therefore pay less attention to them than the preceding portions of the paper, and only extract such passages as relate to the use and estimation of our timber in Europe.

The following calculation may be new to some of our readers, and is we believe, correct:—

"The species of forest trees indigenious to different countries is an interesting subject connected with vegetable physiology. There are said to be about thirty forest trees indigenious to Great Britain, which attain the height of thirty feet; and in France there are about the same number. But according to the best authorities, there are no less than 140 species, which attain a similar height indigenious to the United States."

Appended to the history of the Live Oak are these remarks : —

"There can be little doubt, from its great density and durability, that this is one of the finest species of oak that exists, surpassing even that for which Great Britain is so famous. Its cultivation has been tried in this country without success ; but could it be imported, it would be found admirably suited for the construction of lock-gates and engineering works, for which hard and durable timber is required, and for which English or African oak is generally used."

"The White oak (*Quercus alba*) is the species of which so much is imported into this country. It is known by the name of 'American oak,' but it is a very different and much inferior wood to the live oak of the United States, which I have just described. It is also much more widely distributed, and occurs in much greater quantity, than the live oak. It is very common throughout the northern States and in Canada, from whence it is exported to this country. It attains an elevation of seventy or eighty feet, with a diameter of six or seven feet. It is known by the whiteness of its bark, from which it derives its name, and from a few of its leaves remaining on the branches in a withered state throughout the winter. The wood is of a reddish color, and in that respect is very similar to English oak. But it is generally acknowledged to be greatly inferior to it in strength and durability. It is very straight in the fibre, however, and can be got in pieces of great length and considerable scantling—properties which, for certain purposes, make it preferable to the British oak. It is much used in ship building, and also for the transverse sleepers of railways. There are many other oaks in the United States, but the two I have mentioned, are those most in use."

* * * * * * *

"The White, or Weymouth Pine (*Pinus strobus,*) is widely distributed both in the United States and in Canada, and is exported to Britain in great quantities from the latter country. It is the tallest tree of the American forest, having been known, according to Michaux, to attain the height of 180 feet. The wood has not much strength, but it is free from knots, and is easily wrought. It is very extensively employed in the erection of bridges, particularly *frame* and *lattice* bridges, a construction peculiar to the United States, and very generally adopted in that country, which I have described in detail elsewhere.* For this purpose it is well fitted, on account of

* Stephenson's sketch of the Civil Engineering of North America. London: John Weale, 1838.

its lightness and rigidity, and also because it is found to be less apt to *warp* or *cast* on exposure to the atmosphere than most other timbers of the country. It is much used for the interior fittings of houses, and for the masts and spars of vessels."

Our Yellow pine is not found in Canada and therefore does not reach England.

"The Red pine (*Pinus resinosa,*) is the only other of the pine species that is much used. It occurs in great plenty in the northern and middle States, and in Canada, from whence it is exported in great quantity to this country, and it is known to us by the name of 'American yellow pine.' * * * * * * The wood owing to the resinous matter it contains, is heavy; and is highly esteemed for naval architecture, more especially for decks of vessels, both in this country, and in America."

Of the Locust so extensively cultivated, and of which acres upon ares are planted, Mr. S. says: —

"Its growth being chiefly confined to the United States, it is not imported into Britain. It is one of the very few trees that are planted by the Americans, and may be seen forming hedge-rows in the highly cultivated parts of Pennsylvania."

"The Red cedar (*Juniperus Virginiana,*) is another valuable wood, the growth of which is confined to the United States. In situations where the soil is favorable it grows to the height of 40 or 50 feet, with a diameter of 12 or 13 inches. This wood is of a bright red color; it is odorous, compact, fine grained, and very light, and is used as already stated in ship building, along with live oak and locust to compensate for their weight. It is considered one of the most durable woods of the United States, and being less affected by heat or moisture than almost any other, it is much employed for railway sleepers. I remember, in travelling on some of the railways, to have been most pleasantly regaled for miles together, with the aroma of the newly laid sleepers of this wood. It is now, however, becoming too scarce and valuable to be used for this purpose."

In his concluding notice, Mr. S. abandoning the authority he has safely followed for some time, gives us the result of his own observations in the following singular paragraph: —

"Such is a brief notice of some of the principal timbers of the United States, which, from their great abundance and variety, are suitable for almost every purpose connected with the arts, and thus serve in some degree to compensate for the want of stone, while at

the same time they afford great advantages for the prosecution of every branch of carpentry, an art which has been brought to great perfection in that country. Many ingenious constructions have been devised to render timber applicable to all the purposes of civil architecture, and in no branch of engineering is this more strikingly exemplified than in bridge building. Excepting a few small *rubble arches* of inconsiderable span, there is *not a stone bridge* in the whole of the United States or Canada. But many wooden bridges have been constructed. Several of them, as is well known, are upwards of a mile and a quarter in length, and the celebrated Schuylkill bridge at Philadelphia, which was burnt about two years ago, but was in existence when I visited the country, consisted of a single timber arch of no less than 320 feet span. Canal locks, and aqueducts, weirs, quays, breakwaters, and all manner of engineering works have there been erected, in which wood is the material chiefly employed; so that if we characterize Scotland as a stone, and England as a brick country, we may, notwithstanding its granite and marble, safely characterize the United States as a country of timber."

Where were the famous stone viaducts on the Baltimore and Ohio railroad, and the Washington branch, when our author was in that vicinity? We cannot account for the singular statement, that there are no (dressed) stone bridges in the United States, in any other way than by supposing that the queer crotchet in Mr. Stevenson's brain,—that there was no stone in the United States—led him to imagine that every bridge must necessarily be built of timber, and that satisfied with this hypothesis, he gave himself no further trouble to examine into the matter.

We have thus examined at length, this extraordinary paper, but with other objects than the mere criticism of the ridiculous statements contained in it. We wish to draw the attention of engineers to two important facts which force themselves upon the mind of any one reading Mr. Stevenson's paper. The first of these is the remarkable ignorance which prevail in England and elswhere as to our civil engineering. Such statements could hardly have been admitted into respectable journals, had they not received credit from those who were supposed to be informed on such subjects. The second fact is, that no better information either abroad or in our own country, will be found, until our civil engineers as a profession and in a body, vindicate their practice and thus correct these errors which are so prevalent. It may be thought that the estimation in which they are held abroad, is a matter of little consequence—but

it is far otherwise—if a feeling of self respect is not inducement enough to correct such erroneous estimates, let them recollect that these errors will react upon us, and that we shall, among other evils, suffer an immigration of gentlemen unable to attain any standing at home, and who will be most happy to show our civil engineers how to avoid the violation "of the established rules of engineering as practised in *their* country"—how to build stone bridges of large span, and finally to discover that, although not known before, there is an abundance of stone in the United States.

[For the American Railroad Journal and Mechanics' Magazine.]

NEW YORK AND HARLEM RAILROAD.

A report on the "past management, present condition and future prospects," of this company was issued under date 15th October, 1841, from which we extract the following particulars. The original act of incorporation was dated 25th April, 1831, and the final act of amendment was passed May 7th, 1840—by which the whole capital authorized per amended charter, consists of 59,000 shares of $50 per share, $2,950,000.

By this last act of amendment, the company are authorized to construct their road from the Harlem river, through the county of Westchester to the north line of that county, and eastwardly to the line of the State of Connecticut, and there to intersect with a line or lines from that State or from Massachusetts, etc., etc,

The amount of stock sold is as follows,

26,233 shares at $50, - - - -	1,311,650	
Deduct loss on 11, 420 shares, sold under par	301,178	
		1,010,472.
The loans are, one amount for which there are 4,700 shares at $50 hypothecated	235,000	
One amount, for which the road and appurtenances are mortgaged, - - - -	125,000	
		360,000
		1,370,472
Add loss on 11,520 shares, - - - -		301,178
		$1,671,650

which is represented by a road from City Hall to Harlem of double track, flat bar, - - - - - - - 8 miles.

From Harlem to Fordham, single track, edge rail, 4½ miles.

12½ miles

or in all 20½ miles of single track of road costing about $70,000 per

mile, after deducting $247,660 of real and personal estate, included in the above expenditure of $1,671,650.

If the reader would more clearly understand how little has been obtained for this vast expenditure—let him cross into Jersey City, and examine the road to Brunswick of 37 miles, including 3 of turn-outs, having an edge rail throughout, and an equipment nearly equal to the conduct of the whole line of traffic and travel between New York and Philadelphia—look at Bergen hill—the bottomless swamps filled up—the long bridges on this route—the whole cost of which, exclusive of right of way, does not exceed $1,600,000, and he will see how much the latter have to congratulate themselves on the economy which must have obtained in its construction.

The amount of travel over this road for the year ending September, 1840, was,

From City Hall to 25th street	-	-	$605,477	fare	$6\frac{1}{4}$	cents.
Do. do. Yorkville,	-	-	42,832	do.	$12\frac{1}{2}$	do.
Do. do. Harlem,	-	-	375,272	do.	$18\frac{3}{4}$	do.

These rates of fare are of course regulated by the competition of omnibusses by which the accommodation may be called equally good and some would call better. The following list of fares for travel on the English roads, will serve for a record of the rates which have hitherto obtained there, but being now thought generally too high, the controversy created thereby, has within this year caused important reductions on most of the main lines—the standard now assumed as productive of most travel being $2\frac{1}{2}$ to 3 cents per mile, which for the *despatch and accommodation* there afforded is very cheap indeed. Compare it for instance with the line between New York and Philadelphia, the most important in the United States, where the fare and *loss of time* etc., come to at least ten cents per mile, and not only checks the immediate travel, but that which a better communication would induce both north and south of those points.

Rates of fare on the railroads of Great Britain.

		1st. Class.				*2d. Class.*			
	Length.	*Charge.*			*Cts.*	*Charge.*			*Cts.*
Road.	*Miles.*	£	*s.*	*d.*	*pr. mile*	£	*s.*	*d.*	*mile.*
London and Birmingham,	$112\frac{1}{4}$		30	0	$5\frac{1}{8}$		20	0	$3\frac{7}{8}$
Midland counties,	$49\frac{1}{4}$		10	0	$4\frac{1}{2}$		8	0	$3\frac{1}{2}$
Lancaster and Preston,	21		5	0	$5\frac{3}{8}$		3	0	$3\frac{1}{8}$
Grand Junction,	$97\frac{1}{4}$	1	5	0	$5\frac{1}{4}$	1	3	0	$5\frac{1}{4}$
North Midland,	72	1	2	0	$6\frac{3}{4}$		18	0	$5\frac{1}{2}$
" " and York,	27		5	0	$4\frac{1}{8}$		3	0	$2\frac{1}{2}$

	Length.	1st. Class. Charge.			Cts.	2d Class. Charge.			Cts.
Road.	Miles.	£	s.	d.	pr. mile.	£	s.	d.	mile.
Great Western,	118		14	0	5		10	0	3½
Eastern counties,	17½		4	6	5¾		3	0	3¾
Croydon,	10½		2	0	4		1	6	3
London and Blackwall,	3½		0	6	3		0	3	1½
South Western,	77	1	0	0	5½		12	0	3½
Birmingham & Derby Junc.	38½		—		—		—		—
London and Brighton,	47		—		—		—		—
Birmingham and Gloucester,	59		11	6	5¼		8	0	3⅝
Manchester and Birmingham,	45½		—		—		—		—
Liverpool and Manchester,	31		6	6	6⅝		6	0	4¼
Manchester, B. and Bury,	10		2	6	5½		1	6	3½
Leeds and Selby,	20		4	0	4⅜		3	0	3⅜
Hull and Leeds, Junction,	30¾		8	0	5¾		6	6	4⅝
Sheffield and Ratheham,	5¼		1	0	4		0	6	2
Stockton and Darlington,	40		—		4		—		3
Newcastle upon-Tyne,	61¾		11	0	4		8	6	3
Manchester and Leeds,	50		—		—		—		—
Glasgow and Ayr,	40		6	8	3⅝		5	0	2⅞
Dundee and Arbroath,	16¾		2	6	3½		2	0	2¾

This gives an average of twenty-one railroads, as follows:—

1st Class, - - - - 4¾ cents per mile.
2d. " - - - - 3½ " " "

It need scarcely be stated that at the above scale of travel and fare on the Harlem road, that the receipts are inadequate to meet the current expenses of road and interest on its debts, the latter being stated to fall due as follows:—

Before the 1st day of January, 1842, - - -	$182,000
In the course of the years 1842, '3, '4, '5, '6, and '7,	178,000
	$360,000

As the road now stands we do not see any other result but increased deficiency in the means of meeting its expenses, nor do any of the expedients proposed in this report, seem adequate to save it from sinking deeper and deeper into the abyss in which it is already plunged.

The expedients here referred to, are alluded to in the report as follows:

"The connection of the Harlem railroad company, with the New York and Erie railroad at Piermont, can be effected by constructing a branch of eight miles through an eligible route from the main line of the road to White Plains, and a connection with one of the eastern routes (Housatonic,) may be readily effected from this point."

Against these projects, it may be stated that the present termination of the Erie railroad, will be brought into Jersey City by being tapped at Ramapo by the Paterson railroad, which requires an extension of only 12 miles for that purpose, and the eastern connection so far as the northern travel is concerned, could be superceded by the construction of an entire line of road from the city of New York to Albany, taking the valley of the Saw Mill parallel to the Hudson river, which is maintained by some engineers to be a cheaper route for a railway than that through the valley of the Bronx, now occupied by the Harlem railroad. Besides, during the best part of the year would not the river route to and from Piermont by steamboat be preferred to a mixed one by horse, locomotive, and steamboat?

There never could have been but one legitimate termination for a railway in this direction, and that was at Albany, which however, was not considered by this company in the charter or its amendments. In leaving it where it now is, the results here exhibited, were but natural, and the parties to blame are not so much those having charge of its management, as the whole community between the city of New York and Albany, for thus suffering it to become an inevitable and as it were an *insuperable barrier*, to a connection between them, unless the strong arm of the legislature be made to aid in its removal, or a new route be taken, now that that connection will be found of imperious necessity to the metropolis of the State.

The report furnishes the following remarks:—

"While almost every other considerable city in this Union, has liberally contributed of its means or its credit to put into operation great works of internal improvements, connecting with important parts, the corporation of New York have remained inactive, resting in false security upon the advantages which nature has conferred upon its position, while ART is successfully giving to others all the facilities we enjoy. If the public guardians of the welfare of our city, continue to be insensible to the spirit of advancement, let the people agitate the question, until they are aroused to the support of our commercial pre-eminence.

[For the American Railroad Journal and Mechanics' Magazine.]

DEPRECIATION OR RESERVED FUND ON RAILWAYS,—FROM THE ENGLISH RAILWAY MAGAZINE.

This is understood in England to apply simply as a fund set apart to cover the amount of wear and tear, and actual depreciation of value in the working stock, comprising locomotives, cars, etc., etc.

The real bona fide nett income of a railway, ought to be apportioned to the shareholders, and no part be applied to the liquidation in part or in whole of its capital stock.

Then comes the question as to what is at any given time, really left to divide as actual profit—the current expenses being understood, to include the whole actual expenditure in every shape, and not merely the expenses paid, and which alone it was possible to have paid, but there should be ample security, that what appears in the accounts as nett profit really is such, and that the *future proprietors* are not left responsible for any portion of the expenditure, which has been in fact, incurred and exhausted in earning the present apparent dividend—hence the necessity for a careful periodical valuation of all the perishable stock, which at some time, will require partial or entire renewal. And therefore previously to the declaration and payment of a dividend, the actual value of working stock, etc., not with reference to its price if sold, but simply to its relative efficiency and precise comparative degree of wear and tear, should be ascertained to be, either the same as it originally was, or jointly with a reserved fund or per centage for future expenditure, capable of being made so. The object should be to avoid heaping an unusually larger expenditure on particular periods for wear and tear, going on gradually during a whole series of years. This course is one which every well conducted railway company must and will ultimately adopt.

A little further experience will show the per centage which the valuation will require to be set aside for this purpose, and which will vary on different lines, according with the degree of excellence in the original construction of the stock, and in the *efficiency of the servants and establishments* of each company.

In addition to all the actual disbursements, there is always, going on an imperceptible depreciation *of stock*, which must be provided for in some way or other. In the Liverpool and Manchester company, they have no depreciation fund,—when a new engine is wanted, it is charged in the current expenditure. The Grand Junction adopt the principle of a valuation annually, but this being too much a matter of guess work, on the London and Birmingham road, they prefer the principle of forming a depreciation fund, and setting aside

over and above the ordinary charges for repairs, a certain per centage annually, out of the receipts, to keep up the value of the stock, and which they had fixed at 5 per cent on the value of the carriage stock, 5 cents per mile run by the engine, to provide for its superannuation.

This is an important subject, and has not been very particularly attended to in this country by any of our incorporated companies, whether railways, canals, banks, etc.

In this country, the working stock is found to be amply provided for, or perpetuated by an annual expenditure of, say, on the locomotives of $800, to $1,000 each; on the cars, of 10 to 15 per cent on the cost, modified of course by the quality of each particular road.

In the sketch of a railway, the proportions for a just appropriation for renewal of superstructure and adjustment of road bed is there given as applicable to the particular case of the Philadelphia and Pottsville railway as follows:—

The Rails:

Estimated to last 30 years—8,500 tons per 100 miles, cost originally, say $60, (price of 1837 and '38) - - -	$510,000		
Deduct $20 for old iron, - - -	170,000		
	$340,000		
Or per mile, per annum, - - -		113	
Sills or Crossties:			
Estimated to last 10 years, 170,000 per 100 miles, at 50 cents, - - - -	$85,000		
Or per mile per annum, - - -		85	
Bridges:			
Estimated to last 25 years, costing $450,000 for whole line, or per mile per annum,		180	
			378
Road-Bed:			
Levelling and to keep it true, estimated to require 2 men at every 2 mile station at $27 per month each, making $32,500 per annum for 100 miles, and supposing them, as they should be, *constantly* on the road, per mile per annum, -			325
			703
Management:			
Office rent, salaries, water stations, incidentals, etc., say per mile per annum,			350
			$1,053

We consider the above as a very full allowance, and indeed overcharged in the main item, of iron, which might be more fairly stated as follows:—

We know of a road which has recently been supplied with iron for £7 per ton, for an edge rail, which cost landed here say, $39 for 8,500 tons, would be	331,500
The flat bar sells higher than the edge rail in the shops, but the latter would always command, say, $25 on 8,000 tons	200,000
	$131,500
An appropriation, per mile per annum, of	$45

There is no doubt also of the sills or crossties being had at 30 to 35 cents each, in place of 50 cents, and a less amount would also do for the bridges than is charged above. It is well to bring up these matters to the notice of the public, as on no other subject are they more at fault than in the expense for renewal of railways, which require to be judged separately—take for instance the Long Island railway, which has not a bridge in its whole length of 95 miles. What a saving is here both in original outlay, and in subsequent adjustment and renewal; and then nature has provided it with a gravel bed throughout, in which it may be said to become embalmed and to last for ever!

[For the American Railroad Journal and Mechanics' Magazine.]

OPENING OF THE MANCHESTER AND LEEDS RAILWAY,—LENGTH FIFTY MILES.

On the probable results and expense of working this railway, the chairman remarked, "that although it was scarcely his business to enter much into the future, still he thought it his duty to put the proprietors into possession as far as he could, of all those circumstances which tend to show the ultimate prospects and future increase of the concern. He had looked over with some care the result of the traffic on the London and Birmingham, and Grand Junction, and from these he inferred, it would be likely to reach in 1843, about £6,000 per week."

"The next important subject, was the expense of working the line—taking every pains to ascertain the probable amount, including maintenance of way, the depreciation of stock, and in fact every charge that could come in, he found that with a receipt of £5 to 6,000 per week, their expenditures would not exceed £100,

000, per year, *equal to about* 33 *per cent on the gross receipts.* If they succeeded in keeping it to that amount, they would work their line at a more moderate cost than any other of the large line."

The very superior character of roads in England, give them every advantage in their economical management, at the same time that they afford the best accommodation and despatch. It is perhaps only in the eastern States, that we can as yet, compare with them in these particulars. In most of the later enterprises of railway, the comparison will hold as regards a solidity of road and structure, and our machinery being superior to that of England, we ought hereafter, to make a more favorable show in the comparison.

It has often occurred to us how wide the field will be on the New York and Erie railroad, 468 miles in length, for the display of rivalry in the cheap and efficient management on the 5 or 6 sections into which it will be divided. With this road, and a few others, of similar calibre, in full blast, we may then claim to compare with England in all the points of excellence connected with the railway. This is the right sort of battle ground on which to fight her.

[From the Journal of the Franklin Institute.]

ON CAST IRON RAILS FOR RAILWAYS. *By* Ellwood Morris, *Civil Engineer.*

We are informed in Wood's Treatise upon railroads, that in the early part of the seventeenth century, railroads were first used in England, and they were then formed of wood; *the wooden rails* were employed for about 110 years, when in 1767, *cast iron rails* were first introduced, and thereafter continued for a period of near fifty years, to be used instead of any other material; but in the year 1815 *malleable iron edge rails* were devised, and after Mr. Birkenshaw, in 1820, had obtained his patent for an improvement in the form of such rails, and applied the rolling mill to their manufacture, they were very extensively adopted, and subsequent to that period of time have been almost exclusively used; indeed, since the modern improvements in the means of intercommunication by railways have enabled locomotive steam engines to travel at velocities of thirty miles and more, per hour, the use of *cast iron rails* has been, for the present, laid aside, if not wholly abandoned, on public railways.

The chief reasons which seem to have induced engineers, both here and abroad, so much to prefer *malleable* before *cast iron rails*, as to exclude the latter from use, appear to have been, originally, a belief that,

1. Malleable iron rails were cheaper than those of cast iron.
2. Malleable iron rails being made in longer lengths caused fewer joints.
3. Malleable iron rails were less liable to fracture from concussion.

4. Malleable iron rails were thought to be somewhat more durable.

Although these reasons are very plausible, they have nevertheless been found not to be valid in practice to the full extent that was anticipated by those who fostered them, and with regard to them it may be observed,

I. With respect to the comparative economy of cast and malleable iron rails, it is certain that the latter, in this country at least, are not cheaper than the former, and if made of American rolled iron instead of imported, they would be much more costly.

II. Convenience of handling seems to have fixed the length of wrought iron rails at about fifteen feet, and of this dimension there is but little difficulty either in moulding or casting rails; but it is very questionable whether sufficient practical advantages do not attend cast iron rails of six or ten feet length, to induce a preference to be given to them over others of greater lineal extent.

III. It is unquestionably true that *malleable iron rails* are far stronger than *cast iron* ones of the same dimensions, when exposed to *a direct impulsive force;* indeed, we find it stated in Tredgold's essay on the strength of metals, "that a velocity, (direct,) of 17 six-tenths feet per second, or twelve miles per hour, would break a beam of (cast iron;) or a beam would break by falling from a height of five feet!"

Now if any such force was actually brought to bear upon the rails of railways in practice, it would, of course, be improper to employ those of cast iron, but happily this is rarely, if ever the case, for although Tredgold's statement may be true, when a weight *falls directly* upon a cast iron beam; no such result would ensue from *oblique impact,* with the same momentum that would be generated in the supposed case; and as the concussions produced upon a railway by a train at speed are of the latter character, it becomes necessary to inquire what vertical stress, or pressure, imposed by the wheels, results from their *oblique impact* when in rapid motion upon the rails?

A little reflection will satisfy any one that the impact upon the rail of a carriage wheel running at high speed, is a very different affair from the concussion produced by a weight falling freely; for instance, if an engine with a velocity of thirty miles an hour passes over a rail which, at the joint, is one-tenth of an inch higher than its neighbor, the wheel would advance in the air without touching the rail for the space of *one foot;* for, by gravity, "a body requires one-forty-fourth of a second to fall one-tenth of an inch, and in that space of time a wheel running at the rate of thirty miles an hour would move horizontally forward *one foot;*" in such a case, then, the wheel may be regarded as having traversed in the air an inclined plane, of which the base would be 120 times the altitude, and consequently if the force of impact be resolved by the parallelogram of forces, into two others, one perpendicular to the rail, and the other parallel to it, the former will be not quite the one hundred and twentieth part of the whole impulsive force, instead of being equal to it, as would have been the case if the stroke were

direct, or if the engine had fallen freely by the action of gravity alone through the vertical space of one-tenth of an inch, and the percussive force upon the rail, produced by a free fall through even that small height, would far surpass that which would be created by the one hundred and twentieth part of the oblique momentum of the wheel at the pace of thirty miles an hour.

This reasoning leads us to the conclusion that in such cases the greater the velocity of the engine the less will be the vertical pressure of the wheel upon the rail, and this, to a certain extent, is undoubtedly true, for the horizontal component of the force of impact will be greater than the perpendicular one, just as the velocity is greater.

Upon the same principle it is, that a musket ball shot parallel along a horizontal plane, so as to barely touch it tangentially, will not press upon the plane at all within the limits of its level or point blank range.

Whether these views agree or not, with those commonly entertained concerning fast trains on railways, they are, nevertheless, legitimate deductions from the established doctrine of forces, and serve to account for the small effect produced by the ordinary inequalities of a railroad, as shown in the results displayed by the following direct experiments touching this matter, which were made by Professor Barlow, and recorded in his work on the "strength of materials," English edition, 1837; these experiments are conclusive in their character, and establish, beyond question, the fact, *that the vertical stress imposed upon a railway by the transit of locomotive engines at velocities varying from twenty-two to thirty-two miles an hour, is but little, if any, in excess of that produced by a quiescent load of the same weight!*

These experiments by Professor Barlow, were made with an ingenious and accurate instrument, to determine the deflection of rails under trains running at high speed, and as the deflection of materials under a strain, is as the insistent weight, the vertical pressure upon the rails is by this means accurately indicated.

Experiments.

GJ*

		Deflection in inches of the rail in the middle length.
1. Speedwell engine and train at twenty miles an hour, weight upon the driving wheels nearly six tons, or three tons on each wheel - - - - -	=	.0425 .0400 .0400
2. Ditto same speed - - - - -	=	.0320 .0400 .0420
3. Ditto very slow - - - - -	=	.0240 .0250 .0320
		9).3175

Mean deflection in these experiments, inclusive of the yielding of the stone block supports - - } = .0353

Now, by trials made with direct pressure, upon the same railway bars which were travelled over by the trains in the above experiments, and then taken up and forwarded to Woolwich, for the purpose of examination, Professor Barlow states that the mean deflection, under a load of three tons weight at rest, was = .0314

While the mean deflection, under trains in motion, at velocities as high as twenty miles per hour, as stated above, amounted to - - - - - - - = .0353

Difference - - - - - - - - = .0039

which when we consider that a portion of this difference is due to the depression of the blocks, indicates "a close agreement, which shows, that when every thing is well fixed and secure, the deflexion, and consequently the strain is nearly the same, whether the load be *in motion or at rest;* and that each rail is only pressed with half the weight on one pair of wheels."

The rail tried in the preceding experiments, was that of the Grand Junction railway, weighing sixty-two pounds per yard, and laid with three feet nine inches bearing; in those following, Professor Barlow employed the same pattern of rail, but laid with bearings five feet asunder.

Experiments.

	Deflection in inches of the rail in the middle length.
1. Swiftsure engine, velocity twenty-two miles an hour, three tons weight on each driving wheel - - =	.093 .077 .080
2. Ditto same speed - - - - - - =	.082 .070 .077
3. Speedwell engine, velocity thirty miles an hour =	.112 .091
4. Ditto, velocity thirty-two miles an hour =	.122 .115
5. Fury train, velocity twenty-three miles an hour =	.083 .085
	12)1.087

G J

Mean of these experiments, inclusive of the yielding of the stone block supports - - - } = .090

In experiments made at Woolwich, with vertical weights at rest, upon the same rails, the mean deflection produced at five feet bearing by a quiescent load of three tons, was - - - - - - - = .079

And the mean deflection found above, with three tons on a wheel in motion, at rates from twenty-two to thirty-two miles an hour - - - - - - = .090

Difference, part of which is owing to the depression of the blocks, = .011

Upon the whole series of these experiments, Professor Barlow observes that "nothing can be expected much more satisfactory, as it is thus proved, *independently of any opinion*, that while the blocks and fixings are secure, the strain from a passing load is but little in excess of that from a quiescent load."

The above quotations, demonstrating as they do distinctly, that the vertical stress of trains at speed, surpasses so little the effect of quiescent loads of the same weight, (*that it is only necessary to proportion the rails of railroads to resist quiescent, and not concussive forces,*) change the whole face of the question between *cast and wrought iron rails;* they strike away all the objections heretofore urged against the brittleness of cast iron, for it does not admit of doubt, that a beam of that material, of suitable proportions, is quite as competent to carry a quiescent load as is one of malleable iron; again, a cast iron rail will yield sufficiently to impact, and return to its proper level the moment it is relieved of the weight of a train, for it is well known that its elasticity and power of restoration, after deflection, is within certain limits so perfect, that owing to its regularity in that respect it was even proposed by Tredgold to use beams of cast iron as weighing machines, measuring the weights imposed by the deflections produced!

In view of the conclusive argumeuts of Professor Barlow upon the relative effect of passing and quiescent loads upon railways, we may limit our researches to ascertaining simply the dimensions of a cast iron rail, *which shall have the same surplus strength to resist a quiescent load equal to the maximum weight upon one wheel, as is found in practice to be necessary in a malleable iron rail;* to aid us in this matter we shall again recur to the valuable work from which we have already quoted so much, and upon pages 428 and 430 these statements will be found; that when the road is in good order "the rail is only deflected at the greatest velocity, a little more than is due to a quiescent load, equal to half the weight on two wheels; but that in consequence of imperfections a strain is occasionally thrown on the rail which produces a deflection about double that which belongs to the load in question." And as a consequence of this, results the "experimental fact that with engines of twelve tons weight, (and three tons on a wheel,) running at velocities not exceeding thirty-two or thirty-five miles per hour, *it is not necessary*, even as railways have been hitherto constructed, to provide for a strain of more than seven tons, which is allowing a surplus strength of sixteen per cent,

beyond the double of the mean strain," and this was experimentally found to be a strength amply sufficient to resist the lurching of locomotive engines running at high speed. Tredgold, on the strength of metals, informs us that compared with *cast iron as unity*, the strength of *malleable iron* is $1\frac{12}{100}$ times, and its stiffness $1\frac{3}{10}$ times.

Now as the stiffness of rails is a matter of such importance as to be almost the controlling desideratum upon railroads, having in fact, induced the preference given to parallel over fish-bellied rails, it would perhaps, be proper so to proportion cast iron rails that they may be *as stiff* as those of malleable iron of suitable strength; hen ce in the case of a railway destined to carry at a high speed locomotive engines of twelve tons weight, and running three tons upon a wheel, as assumed by Professor Barlow, if *a wrought iron rail* possessing an elastic strength of seven tons* is sufficient, *a cast iron one* to have the same stiffness should be proportioned to resist a vertical weight of nine tons, for supposing the stiffness to be as the weights imposed, and the comparative flexibility of the two materials, we have $1 : 1.3 :: 7 : 9.1$, which would give an excess of strength to the cast iron rail in the ratio of $1\frac{3}{10}$ to $1\frac{12}{100}$.

Therefore it will be perfectly safe to assume, as the proper size for *cast iron rails*, sufficient dimensions to give them such a transverse section, as with the fixed length of bearing, will furnish a strength equal to *three times the maximum weight designed to be imposed upon any wheel*, and this is precisely the same conclusion as is arrived at by Mr. Wood, in his valuable treatise on railways, third edition, page 130.

The proportions proper for the section of a cast iron rail may be readily ascertained, either by the formula of Tredgold, which give an excess of strength, and the accuracy of which, up to the limit of perfect elasticity, has lately received ample confimation;† or the section may be more conveniently determined by the accurate rules given by Professor Barlow, for malleable iron rails, as quoted in the third edition of Wood on railroads, allowing for the difference between the two materials in the ratio of 1 to $1\frac{3}{10}$.

If notwithstanding all that has above been said concerning the capacity of cast iron rails to endure successfully the strains which really exist in railway practice, fears should still be entertained of their sudden fracture under trains at speed, all such fears may be completely nullified, by casting in the centre of the head, or top table of the rail, a rod of malleable iron of about a half an inch in diameter, as has already been done with success in cast iron wheels,‡

* The necessity of proportioning rails to resist strains so mnch greater than is really produced upon a way in accurate adjustment, arises chiefly froman unequal settlement taking place in the two lines of rails, producing that lurching of carriages which sometimes doubles the weight upon a wheel; now, if in all cuttings, and upon all well consolidated embankments, both lines of rails were laid upon *a continuous bed of concrete*, of sufficient depth and width, it would be impossibie for the rails to settle irregularly, and if they subsided at all, it would be so equally as to preserve still the proper relation to each other.

† See experiments on the strength of cast iron, by Francis Bramah, Civil Engineer, in the second volume, Trans. Inst. Civ. Eng.

‡ At the works of the New Castle, (Del.) Manufacturing Company, and also at other places, by this operation the strength of wheels is very materilly augmented.

to prevent an immediate separation of the fragments in case of sudden breakage; and in addition to subserving its purpose effectually the wrought iron rod would improve the chill of the head of the cast iron rail to an adamantine hardness.

These observations apply especially to rails supported at intervals only, as is now the usual practice; but if the plan of *continuous bearings** should be generally adopted in railways, the propriety of which has been strongly urged by English engineers, (see an able paper by J. Reynolds, Esq., Civil Engineer, recorded in the second volume Trans. Inst. Civ. Eng.,) as a perfect remedy for acknowledged defects, and which method has been used with success by Mr. Brunel upon the Great Western Railway; *all objections against cast iron rails must wholly vanish;* and with regard to railways of continuous bearing, if the preservative processes now applied to timber should fully answer their intended purpose, without too much expense, as now seems highly probably, it cannot be questioned, that if laid upon Herron's patent trellis plan, or in some other mode, which, with continuous bearing, furnishes also the requisite solidity of foundation, and strength of lateral tie, such roads will possess unquestionable advantages over those laid with isolated supports.

There is another very important fact developed by the judicious experiments of Professor Barlow, which demands the attention of engineers in all subsequent railways, (particularly if they are not of continuous bearing,) whether laid with cast, or malleable iron; and that is, that if rails are supported by isolated bearings at *uniform* distances asunder, *they deflect unequally between the supports, when traversed by the trains;* the joint lengths are the most flexible, and consequently, in order that the railway may be equally stiff in every part, the rails must either be made of greater size in the joint bearings, or else the supports at the joint ends must be brought nearer together, in the same proportion as the deflection of the joint length beneath a passing train is greater.

Professor Barlow found by experiments made with his accurate deflectometer, that the heavy rails of the Grand Junction railway, laid with uniform bearings, deflected under trains running at velocities as high as thirty-two miles an hour, .121 in the joint lengths, when in the middle lengths the deflection was only .090 of an inch.

Consequently, if the rails are of such length as to span *more than two spaces,* and if one of the middle bearings, or spaces, be assumed $= x$, then the joint bearing, if the rail has every where the same traneverse section, must be made $= \sqrt[3]{\frac{.090}{.121} x^3}$, or $\sqrt[3]{\frac{3}{4} x^3}$, because the deflection is as the cube of the bearing length; thus if the strength of a rail be calculated for bearings of three feet, and that distance be assumed for the central lengths between the supports,

* The tendency of the extensive practice which has now been had on railways is certainly establishing gradually in the minds of engineers a conviction of the superiority of roads of continuous bearing laid with the U, or bridge rail, over those of any other construction.

the joint lengths to make the rail equally stiff throughout must be

$$\sqrt[3]{27 \times \frac{.090}{121}} = 2\tfrac{7}{10} \text{ feet.*}$$

The principle that the deflections of rails of the same section are *as the cubes of their bearing lengths,* obtains, as a matter of course, in the case of trains at speed; thus in the experiments heretofore cited, the deflection of the Grand Junction rails, with three and three quarter feet bearing, was found by the deflectometer to be 0.353; consequently the same rails, at five feet bearing, under trains of the same weight ought to have deflected $\frac{.0353 \times (5)^3}{(3\frac{3}{4})^3} = .084$, the actual deflection found by experiment was .090, a sufficiently near coincidence.

[To be continued.]

[From the Civil Engineer and Architect's Journal.]

ENGINEERING WORKS OF THE ANCIENTS.

In our last we gave an account from Xenophon of the Athenian silver mines, which, by some inadvertence, was detached from this series of papers, and now we proceed to give what Diodorus Siculus says as to the gold mines of Ethiopia (book 3.)

Egyptian or Ethiopian gold mines.—In the confines of Egypt and the neighboring countries of Arabia and Ethiopia there is a place full of rich gold mines, out of which with much cost and pains of many laborers, gold is dug. The soil here naturally is black, but in the body of the earth, run many white veins, shining with white marble, (query quartz,) and glistening with all sorts of other bright metals, out of which ,laborious miners, those appointed overseers cause the gold to be dug up by the labor of a vast multitude of people. For the kings of Egypt condemn to these mines notorious crimnals, captives taken in war, persons sometimes falsely accused, or such against whom the king is incensed; and that not only they themselves, but sometimes all their kindred, and relations with them, are sent to work here, both to punish them, and by their labor to advance the profit and gain of the king. There are infinite numbers upon these accounts thrust down into these mines, all bound in fetters, where they work continually, without being permitted any rest day or night, and so strictly guarded, that there is no possibility or way left to make an escape. For they set over them barbarians, soldiers of various and strange languages, so that it is not possible to corrupt any of the guard, by discoursing one with another, or by gaining opportunities of familiar converse.

The earth which is hardest and full of gold, they soften by putting fire under it, and then work it out with their hands; the rocks thus softened, and made more pliant and yielding, several thousands

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*The system of spacing the bearings unequally has been observed by those able Civil Engineers, Messrs. Knight and Latrobe, in planning the new track recently laid upon the Baltimore and Ohio railroad.

of profligate wretches break it in pieces with hammers and pickaxes. There is one workman who is the overseer of the whole work, who marks out the stone, and shows the laborers the way and manner how he would have it done. Those that are the strongest among them that are appointed to this slavery, provided with sharp iron pickaxes, cleave the marble shining rock by mere force and strength, and not by slight of hand. They undermine not the rock in a direct line, but follow the bright shining vein of the mine. They carry lamps fastened to their foreheads to give them light, being otherwise in perfect darkness in the various windings and turnings wrought in the mine; and having their bodies appearing sometimes of one color and sometimes of another (according to the nature of the mine where they work.) They throw the lumps and pieces of the stone cut out of the rock upon the floor. And thus they are employed continually without intermission, at the very nod of the overseer or taskmaster, who lashes them severely besides. And there are little boys that attend upon the laborers in the mines, and with great labor and toil gather up the lumps and pieces hewn out of the rock as they are cast upon the ground, and carry them forth and lay them upon the bank. Those that are about thirty years of age take a piece of the rock of such a certain quantity, and pound it in a stone morter with iron pestles till it be as small as a pea, then those little stones so pounded are taken from them by the women and older men who cast them into mills that stand together near at hand there in a long row, and two or three of them being employed at one mill, they grind it so long till it be as small as fine meal, according to the patern given them. No care at all is taken of the bodies of those poor creatures, so that they have not a rag so much as to cover their nakedness, and no man that sees them can choose but must commiserate their sad and deplorable condition. For though they are sick, maimed or lamed, no rest nor intermission in the least is allowed them, neither the weakness of old age nor the infirmities of women are any plea to excuse them; but all are driven to their work with blows and cudgelling, till at length overborne with the intolerable weight of their misery, they drop down dead in the midst of their insufferable labors; so that these miserable creatures always expect worse to come than that which they at present endure, and, therefore long for death as far more desirable than life.

At length the masters of the work take stone thus ground to powder, and carry it away in order to the perfecting of it. They spread the mineral so ground upon a broad board somewhat hollow and lying shelving, and pouring water upon it, rub it and cleanse it, and so all the earthy and drossy parts being seperated from the rest by the water, it runs off the board, and the gold by reason of its weight remains behind. Then washing it several times again, they first rub it lightly with their hands, afterwards they draw up the earthy and drossy matter with slender sponges gently applied to the powdered dust, till it be clean pure gold. At last other workmen take it away by weight and measure, and they put it into earthen urns, and according to the quantity of the gold in every

urn, they mix it with some lead, grains of salt, a little tin, and barley bran; then covering the pot close, and carefully daubing them with clay, they put them in a furnace where they abide five days and nights together; then after a convenient time that they have stood to cool, nothing of the other matter is to be found in the pots, but only pure refined gold, some little diminished in the weight.

And thus is gold prepared in the borders of Egypt, and perfected and completed with so many and so great toils and vexations. And therefore I cannot but conclude that nature itself teaches us, that as gold is got with labor and toil, so it is kept with difficulty, creates everywhere the greatest cares, and the use of it is mixed both with pleasure and sorrow. Yet the invention of those metals is very ancient, being found out, and made use of by the ancient kings.

Assyrian Engineering.—Keeping Diodorus Siculus as our guide, we now come to such notes as he has left of Assyrian engineering. (Book second.)

Walls of Nineveh.—Ninus (1950 B. C.) is styled the builder of Nineveh, having provided money and treasure and other things necessary for the purpose, he built a city near the river Euphrates, very famous for its walls and fortifications, of a long form; for on both sides it ran out in length above a hundred and fifty furlongs; but the two lesser angles were only ninety furlongs a piece; so that the circumference of the whole was four hundred and fourscore furlongs. And the founder was not herein deceived, for none ever built the like, either as to the largeness of its circumference, or the stateliness of its walls; for the wall was a hundred feet in heigth, and so broad that three chariots might be driven together upon it abreast. There were fifteen hundred turrets upon the walls each of them two hundred feet high.

Babylon.—Semiramis, the wife of Ninus, was the founder of Babylon. To this end having provided architects, artists, and all other necessaries for the work, she got together two millions of men out of all parts of the empire to be employed in the building of the city. It was so built that the river Euphrates ran through the middle of it, and she compassed it round with a wall of three hundred and sixty furlongs in circut, and adorned with many stately turrets; and such was the state and grandeur of the work, that the walls were of that breadth that six chariots abreast might be driven together upon them. Their height was such as exceeded all men's belief that heard of it (as Ctesias Cnidius relates.) But Clitarchus, and those who afterwards went over with Alexander into Asia, have written that the walls were in circuit three hundred and sixty-five furlongs; the queen making them of that compass, to the end that the furlongs should be as many in number as the days of the year. The walls were of brick cemented with asphalte; in height, as Ctesias says, fifty fathoms; but as some of the later writers report, but fifty cubits only, and that the breadth was but little more than what would allow two chariots to be driven afront. There were two hundred and fifty turrets in height and thickness

proportionable to the largeness of the wall. It is not to be wondered at that there were so few towers upon a wall of so great circuit, seeing that in many places round the city, there were deep morasses; so that it was judged to no purpose to raise turrets in places so naturally fortified. Between the wall and the houses there was a space left round the city of two hundred feet. That the work might be the more speedily dispatched, to each of her friends was alotted a furlong, with an allowance of all expenses necessary for their several parts, and commanded all should be finished in a year's time; which being dilligently perfected to the queen's approbation, she then made a bridge over the narrowest part of the river five furlongs in length, laying the supports and pil-
124 lars of the arches with great art and skill in the bottom of the water twelve feet distance from each other. That the stones might be the more firmly joined, they were bound together with hooks of iron, and the joints filled up with molten lead. And before the pillars she made defences (sterlings) with sharp pointed angles, to receive the water before it beat upon the flat sides of the pillars, which caused the course of the water to run round by degrees gently and moderately as far as to the broad sides of the pillars, so that the sharp points of the angles cut the stream, and gave a check to its violence, and the roundness of them by little and little giving way, abated the force of the current. This bridge was floored with great joists and planks of cedar, cypress and palm trees, and was thirty feet in breadth, and for art and curiosity yielded to none of the works of Semiramis. On either side of the river she raised a bank, as broad as the wall, and with great cost drew it out in length a hundred furlongs. Semiramis built likewise two palaces at each end of the bridge, upon the bank of the river, whence she might have a prospect over the whole city, and make her passage as by keys to the most convenient places in it as she had occasion. And whereas Euphrates runs through the middle of Babylon, making its course to the south, the palaces lie the one on the east, and the other on the west side of the river, both built at exceeding cost and expense. For that on the west had a high and stately wall, made of burnt brick, sixty furlongs in compass; within this was drawn another of a round form, upon which were portrayed in the bricks, before they were burned, all sorts of living creatures, as if it were to the life, laid with great art in curious colors. Our author goes on further to describe the ornaments of the places, which as less connected with our object we omit. He also describes the formation of a vaulted passage between the two palaces under the Euphrates, made by diverting the river. He says that the walls of this vault were twenty bricks in thickness, and twelve feet high, beside and above the arches; and the breadth was fifteen feet. The arches were of firm and strong brick, and plastered all over on both sides with bitumen four cubits thick. This piece of work being finished in two hundred and sixty days, the river was turned into its ancient channel again.

Semiramis's way.—In a march towards Ecbatana, Semiramis arri-

ved at the mountain Larcheum, which being many furlongs in extent, and full of steep precipices and craggy rocks, there was no passing but by long and tedious windings and turnings. To leave therefore behind her an eternal monument of her name, and to make a short cut for her passage, she caused the rocks to be hewn down, and the valleys to be filled up with earth, and so in a short time at a vast expense laid the way open and plain, which to this day is called Semiramis's way.

Aqueduct at Ecbatana.—Besides this road, when she came to Ecbatana, which is situated in a low and even plain, she built there a stately palace, and bestowed more of her care and pains than she had done at any other place. For the city wanting water, (there being no spring near) she plentifully supplied it with good and wholesome water, brought thither with a great deal of toil and expense after this manner. There is a mountain called Orontes, twelve furlongs distant from the city, exceedingly high and steep for the space of five and twenty furlongs (query) up to the top; on the other side of this mountain there is a great lake which empties itself into the river. At the foot of this mountain she dug a canal fifteen feet in breadth and forty in depth, through which she conveyed water in great abundance into the city.

Bridge of boats.—In the expedition into India, Diodorus relates that to cross the river, she carried with her boats, and made a bridge of boats by which she crossed.

Semiramis deified.—After her death or disappearance, Semiramis was adored by the Assyrians in the form of a dove, it being believed that she was enthroned among the gods.

Memnon's Causeway.—Of this work Diodorus gives the following account. Memnon the son of Tithon, governor of Persia, was in the flower of his age, strong and courageous, and had built a palace in the citadel of Susa, which retained the name of Memnonia to the time of the Persian empire. He paved also there a common highway, which is called Memnon's way to this day; but the Ethiopians of Egypt question this, and say that Memnon was their countryman, and show several ancient palaces, which (they say) retain his name to this day, being called Memnon's palaces.

We shall now cull from the fifth book of Diodorus a number of desultory notes on different subjects, and first as to the

Iron mines of Ethalia.—This island (Elba) abounds with iron stone, which they dig and cut out of the ground to melt, in order for the making of iron; much of which metal is in this sort of stone. The workmen employed first, cut the stones in pieces, and then melt them in furnaces, built and prepared for the purpose. In these furnaces, the stones by the violent heat of the fire, are melted into several pieces in form like to great sponges, which the merchants buy by truck and exchange of other wares, and transport them to Dicearchia, and other mart towns.

Tin mines of Britain.—Now we shall speak something of the tin

which is dug and gotten here. They who inhabit the British promontory of Bolerium by reason of their converse with merchants, are more civilized and courteous to strangers than the rest are. These are the people that make the tin, which with a great deal of care and labor they dig out of the ground; and that being rocky, the metal is mixed with some veins of earth, out of which they melt the metal, and then refine it. Then they beat it into four square pieces like to a die, and carry it to a British Isle near at hand, called Ictis (Wight.)*

Gold mines of Gaul—Arms.—In Gaul there are no silver mines, but much gold, with which the nature of the place supplies the inhabitants, without the labor or toil of digging in the mines. For the winding course of the river washing with its streams the foot of the mountain, carries away great pieces of golden earth; and when it is so done, they cleanse them from the gross earthy part, by washing them in water, and then melt them in a furnace; and thus get together a vast heap of gold, with which not only the women, but the men deck and adorn themselves.

As the arms used by the Gauls are calculated to show the progress made by them in the working of other metals, we copy the following descriptions. Some carry on their shields the shapes of beasts in brass, artificially wrought, as well for defence as ornament. Upon their heads they wear helmets of brass, with large pieces of work, raised upon them for ostentation sake, to be admired by the beholders; for they have either horns of the same metal joined to them, or the shape of birds and beasts carved upon them. Some of them wear iron breastplates, and hooked; but others, content with what arm nature affords them, fight naked. For swords they use a long and broad weapon called *spatha*, which they hang across their right thigh by iron or brazen chains. Some gird themselves over their coats, with belts, ornamented with gold or silver. For darts they cast those they call lances, the iron shafts of which are a cubit or more in length, and almost two hands in breadth.

Celtiberian mode of preparing iron.—They carry two edged swords exactly tempered with steel, and have daggers beside of a span long, which they make use of in close fights. They make weapons and darts in an admirable manner, for they bury plates of iron so long under ground, till the rust hath consumed the greater part, and so the rest becomes more strong and firm; of this they make their swords and other warlike weapons, and with these arms thus tempered, they so cut through every thing in their way, that neither shield, helmet, nor bone can withstand them.

Silver mines of Spain.—Having related what concerns the Iberians, we conceive it not impertinent to say something of their silver mines; for almost all this country is full of such mines, whence is dug very good and pure silver; from which those who deal in that metal gain exceeding great profit. The Pyrenean mountains are the highest and greatest of all others, and being full of woods, and thick of trees, it is reported that in ancient times this mountanous

* Valso Spain.

tract was set on fire by some shepherds, and continuing burning for many days together, (whence the mountains were called Pyrenean or firey,) the parched superficies of the earth sweated abundance of silver, and the ore being melted, the metal flowed down in streams of pure silver, like a river; the use whereof being unknown to the inhabitants, the Phenician merchants bought it for trifles given for it in exchange, and by transporting it into Greece, Asia and all other countries, greatly enriched themselves; and such was their covetousness, that when they had fully laden their ships, and had much more silver to bring abroad, they cut off the lead from their anchors, and made use of silver instead of the other. The Phenicians for a long time using this trade, and so growing more and more wealthy, sent many colonies into Sicily and the neighboring islands, and at length into Africa and Sardinia; but a long time after the Iberians coming to understand the nature of the metal, sank many large mines, whence they dug an infinite quantity of pure silver, (as never was the like almost in any other place of the world,) whereby they gained exceeding great wealth and revenues. The manner of working in these mines, and ordering the metal among the Iberians is thus; there being extraordinary rich mines in this country of gold, as well as of silver and brass, the laborers in the brass take a fourth part of the pure brass dug up, to their own use, and the common laborers in silver have a Euboick talent for their labor in three days time; for the whole soil is full of solid and shining ore, so that both the nature of the ground, and the industry of the workmen is admirable. At the first every common person might dig for this metal, and in regard that the silver ore was easily got, ordinary men grew very rich; but after Iberia came into the hands of the Romans, the mines were managed by a throng of Italians, whose covetousness loaded them with abundance of riches, for they bought a great number of slaves, and delivered them to the task masters and overseers of the mines. These slaves open the mouths of the mine in many places, where digging deep into the ground, are found massy clods of earth, full of gold and silver; and in sinking both in length and depth, they carry on their works in undermining the earth many furlongs distance, the workmen every way here and there making galleries under ground, and bringing up all the massy pieces of ore, (whence the profit and gain is to be had,) even out of the lowest bowels of the earth. There is a great difference between these mines and those in Attica; for besides the labor, they that search there are at great cost and charge; and besides are often frustrated of their hopes, and sometimes lose what they had found, so that they seem to be unfortunate to a proverb. But those in Iberia who deal in mines, according to their expectations, are greatly enriched by their labors; for they succeed at the very first sinking, and afterwards by reason of the extraordinary richness of the soil, they find more and more resplendent veins of ore, full of gold and silver; for the whole soil round about is interlaced on every hand with these metals. Sometimes at a great depth they meet with rivers under ground, but by art give a check to the violence of their current; for by cutting of trenches under ground, they divert the

stream; and being sure to gain what they aim at, when they have begun, they never leave till they have finished it; and to admiration they pump out these floods of water with those instruments called Egyptian pumps, invented by Archimedes the Syracusan, when he was in Egypt. By these with constant pumping by turns they throw up the water to the mouth of the pit, and by this means drain the mine dry, and make the place fit for their work. For this engine is so ingeniously contrived, that a vast quantity of water is strangely with little labor cast out, and the whole flux is thrown up from the very bottom to the surface of the earth. The ingenuity of the artist is justly to be admired, not only in these pumps, but in many other far greater things, for which he is famous all the world over, of which we shall distinctly give an exact enumeration, when we come to the time wherein he lived. Now though these slaves that continue as so many prisoners in these mines, incredibly enrich their masters by their labor, yet toiling night and day in these golden prisons, many of them by being over wrought, die under ground; for they have no rest or intermission from their labors; but the taskmasters by stripes force them to intolerable hardships, so that at length they die most miserably. Some that through the strength of their bodies, and vigor of their spirits are able to endure it, continue a long time in those miseries, whose calamities are such, that death to them is far more eligible than life. Since these mines afforded such wonderful riches, it may be greatly admired that none appear to have been sunk of later times; but in answer thereunto the covetousness of the Carthaginians, when they were masters of Spain, opened all.

In many places of Spain there is also found tin; but not upon the surface of the ground as some historians report, but they dig it up and melt it down as they do gold and silver. Above Lusitania there is much of this tin metal that is in the islands lying in the ocean over against Iberia, which are therefore called Cassiterides; and much of it is likewise transported out of Britain into Gaul, the opposite continent.

COST OF STEAM SHIPS.

The construction of the noble steam frigate *Kamschatka*, at New York, by contract, for the Russian Government, has been made the occasion in a New York paper of some comparisons between her cost and that of the two steam frigates (the *Missouri* and *Mississippi*) building at the New York and Philadelphia navy yards by our Government, unfavorable to the latter; it being alleged that these cost $900,000 each, while the Kamschatka, of three hundred tons burden more than either of them, cost but $450,000. This allegation has been met by the North American of Philadelphia, with sundry refutory statements which, in justice to the Navy Commissioners, we think it proper to transfer to our columns—divesting them of every thing beyond the naked facts presented.—*Nat. Intelligencer.*

"The public have been amused ever since the launching of the Kamschatka frigate, with boastings of her qualities, performances,

and cheapness of construction. And in extoling this vessel, pains have been taken to hold her in contrast with our Government steam frigates now being constructed, and to prejudice the public mind against these vessels and the administration under which they are building.

"We are not conversant with the acts of the Navy Board in former years, but whatever may have been the errors in times past, the noble specimens of naval architecture which have been constructed under their supervision and orders, and presented to the American public in the two steam frigates *Missouri* and *Mississippi*, ought to entitle them to entire confidence. Of the machinery and performance of these vessels we will not speak, because it has not yet been brought to the test of trial, and we do not feel disposed to take a hand at 'the game of brag.' When completed, these ships will tell their own story, but as specimens of naval architecture they are before the world, and stand, by the verdict of public opinion, unsurpassed, even by the vaunted Kamschatka, whose beautiful proportions have been so justly admired. But to the article in question:—

"It is charged that the 'navy ships will cost upwards of $900,000 each.' That 'the Kamschatka is three hundred tons larger,' with 'two decks instead of one,' and is 'superior in workmanship and engines,' and 'will be delivered in Cronstadt for $450,000 or less,' 'including Schuyler's profit of $30,000,' all which we will show to be the reverse of the truth, so far as regards the American vessels, from information derived from the most authentic sources. We have also information on which we place firm reliance, that the cost of the Russian is enormously underrated, and that she will not be delivered at Cronstadt short of $600,000.

"All three of these vessels are two deckers, (and as such we have rated the tonnage) except in the engine rooms, where they all have single decks.

"The Missouri and Mississippi measure on the upper deck, from the front of the stem to aft stern post, ranged up, 224 feet long.

"Breadth of beam, 40 feet.

"Depth of hold, 23 feet 6 inches.

"Tonnage measured as two deckers, 1,684 20·95 tons.

"The Kamschatka measures as above, 219 feet.

"Breadth of beam at the paddle wheel shaft, 35 feet 10 inches.

"Depth of hold, 24 feet 6 inches.

"Tonnage by the same rule, 1,385 89·95 tons.

"The Kamschatka is sponson built. That is to say, she widens above the water line fore and aft the water wheels, in order to give her a more roomy deck. The breadth here given is the body of the vessel as she sits upon the water. But the act of Congress, which was not intended for a craft of this build, requires the measurement of breadth to be at the widest point above the wales, and consequently the register gives a fallacious tonnage of 1,787 46·95; the breadth across the sponsons being 41 feet 10 inches; the real breadth at the water line being 3 feet 2 inches narrower than the navy ships. The cost of the Missouri and Mississippi has been as-

certained with as much accuracy as their state of forwardness will admit, within a short period. Including their armament, the expense of these vessels, fitted complete, will not vary five per cent. from one million of dollars, or FIVE HUNDRED THOUSAND dollars each. But we have some deductions to make. The frame of the Kamschatka is the frame of a 1.400 ton ship, while the frames of the American vessels are of 1.700 tons. The frame of the Russian is white oak, worth forty cents a foot, and will rot in ten years. The frames of the Americans are Florida live oak, of larger dimensions, costing one dollar and seventy-five cents a cubic foot, and will last for ages. The Kamschatka is fastened with wooden trenails. The Americans are fastened throughout with copper, without a trenail in them. Let us put this to figures :—

21,000 cubic feet of live oak timber in the American frames, at $1 75 - - -	$36,750	
16,000 cubic feet of white oak in the Russian, at 40 cents - - - -	6,400	
Difference - - - - -		30,350
100,000 lbs. copper fastening in Americans, at 25 cents per lb. - - - -	25,000	
20,000 lbs. copper fastening in Russian, at 25 cents per lb. - - - -	5,000	
Difference - - - -		20,000
These two items of materials give - - in excess for the American ships, expended to make the ships more lasting and stable, and to save future repairs.		$50,350
We have given the cost of the American, each		$500,000
To bring them on an equality with the Russian in point of quality, we must deduct - -		50,350
Showing the cost to be - - - - or about the same as the pretented cost of that vessel.		$449,650

"These are but two items of excess, for it must be borne in mind that every dimension about the Russian was less than the American in the proportion of fourteen to seventeen.

"But we have another test of comparative cost, which cannot be controverted.

"We will assume for the moment that the materials of the two vessels were of similar cost. The displacement of a ship in tons of water is the weight of the ship in tons, and the comparative cost of two ships should be nearly as their weights. The Russian's displacement, with all machinery on board, was, or ought to have been, 2,100 tons. The displacement of the American's with all on board, will be 2,700 tons, consequently the costs respectively should be as 21 is to 27.

"Now the American costs $500,000. Therefore, the Russian, by this proportion, ought to have cost $390,000 ; and if we take

the proportionate tonnage, she ought to have cost about $400,000; which brings the two modes of estimating very close.

"We think we have clearly shown that the much abused Navy Board have built two ships, superior in every respect to the Russian frigate, at a *saving* of sixty thousand dollars over the cost of the Kamsckatka."

PENNSYLVANIA AND NEW YORK IMPOVENENTS.

The great advantages possessed by the New York canals over our own State improvements, both in their superior management and the comparative lowness of the tolls, has long been a cause of reproach to our own State, and of regret to her citizens. Those having charge of our canals have flattered themselves that on account of the shortness of our route, the avoiding of the danger of the lakes, and the earlier and the later periods of the season in which they were navigable, would obviate the objections of high tolls and frequent detentions on account of breaks. But they were mistaken. While the business on the New York canals has almost doubled this season, our canal men and commission merchants are complaining for want of business.

A gentleman, who is a warm friend to our improvements, informed us a few days since, that he had lately conversed with an intelligent merchant of Beaver, who informed him that he had made the following experiment, in order to ascertain which route possessed the greatest advantage for shipping goods to the west. He purchased a lot of groceries in New York, and ordered a part to be sent by way of the New York canal, the lakes, and the Ohio and Crosscut canals, and part by the Pennsylvania improvements. The result was as follows. The merchandize by way of the New York route, delivered in Bridgewater, (near Beaver,) cost $1,15 per 100 lbs., freight paid in currency, while on the Pennsylvania route, it cost $1,50 in par money; and *three days longer on the way* than by the New York route.

The same gentleman also informed us that a barrel of flour could be shipped from Massillon, on the Ohio canal, to New York, for 93 cents per bbl., while on the Pennsylvania canal the toll alone is $1,25.

How can it be expected that our canals should prosper with such drawbacks as these to their prosperity? The wonder is that there is so much business done on them as is still doing, and this fact shows that our improvements possess great natural advantages over the New York route, and that with low tolls and good management would do the best business.

A few days ago we published an account of an investigation into the comparative profits of railroads conducted with high and low tolls, the results of which were decidedly in favor of *low rates of toll*. We have no doubt the same will hold good in reference to canals. Official reports of the business done on the New York canals this season exhibit an immense increase of profits from tolls over any former year, and it is expected will amount to the enormous sum

of nearly *two millions of dollars.* These canals are conducted on the *low toll* system. We have as yet seen no exhibit of the amount of toll received from our State improvements, for this season, but from the falling off of business, the amount will probably be less than last year, and will doubtless be less than *one half* the amount received on the New York improvements. Our canals are conducted on the *high toll* system.

We present these facts to call public attention to the matter, and especially to direct the attention of Mr. Butler, the new canal commissioner, to the subject. Every citizen of Pennsylvania is concerned in this matter. We have spent millions of dollars to construct these improvements, and have involved ourselves in an enormous debt which must be paid, and yet after all, through improper management, our works do not produce money enough to pay for keeping them in repair. This is a humbling and lamentable state of affairs, and calls for a proper and efficient remedy to be applied. Mr. Butler is said, by his friends, to be intelligent and patriotic—devoted to the interests of Pittsburgh and the State, and we shall therefore soon expect to hear a good account of his management of our affairs.—*Pittsburgh Gazette.*

The western railroad.—The directors of the Western and Boston and Worcester railroads, in anticipation of the speedy opening of the Albany and West Stockbridge railroad from Greenbush to the point where it unites with the Hudson and Berkshire railroad, by which a continuous railroad line will be extended from Boston to Albany, have established the rates of fare and freight for the ensuing winter. The passenger fare from Boston to Albany is established at $5,50; from Boston to Pittsfield, $4⅛; and second class fares, half those prices.

The charges for freight will be for the first class, embracing the more valuable description of goods, $10 per ton of 2000 lbs; for the second class, embracing groceries, and many agricultural products, $8; the third class, embracing the least valuable products, $6,50; and flour, 50 cents per barrel. The fares for places in the interior are of course at higher rates, according to distance.

Railroad fares.—A committee was appointed some time since, by the Government of England, to make inquiries in different parts of Europe, concerning the comparative advantage of high and low fares on railroads. The result of these inquiries, with all the details, containing the answers to upwards of eleven thousand questions, put by the committee, has been published by the British Parliament, and has uniformly presented in every case the conclusion that a low rate of freight creates great quantities of goods to be carried, and thereby becomes the most profitable; that great masses of passengers are created by the low fare; and that a rise of fare has invariably diminished the nett income, and a reduction of fare has invariably increased it.—*Philadelphia American Sentinel.*

The Scotch capitalists who have a high reputation for shrewdness in their money investments, have been of late among the principal purchasers of Great Western, South Western, and Brighton railway stocks.—*London Railway Times.*